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Description of the Invention

Applicant's invention relates to a method for preparing membrane electrode assemblies (MEAs), and in particular to a method of manufacturing a proton-conducting cation-exchange electrolyte membrane for use in a membrane electrode assembly (MEA), in which atmospheric pressure plasma deposition is used to deposit catalysts such as platinum onto a polymer substrate, or a substrate including carbon cloth or carbon particles. The invention has three principal characteristics:

1) The noble metal catalyst is deposited on the membrane by discharge enhanced chemical vapor deposition (DECVD); and

2) The DECVD is carried out at atmospheric pressure, without adding noble gases to the DECVD carrier gas.

3) The reactants included in a carrier gas pass directly between 2 or more electrodes

REMARKS

Claims 1, 3-9, and 11-16 are pending, and stand rejected.

Response to the Examiner's Response to Applicant's Arguments:

Fukuda:

1. The Examiner contends that the Fuduka reference teaches (as in Figure 2) that the reactant gas in a carrier gas passes directly between two electrodes (2 and 5), and therefore rejects Applicant's claims that the reactants in a carrier gas pass directly between 2 or more electrodes. While the difference is subtle, it is extremely important! The Fukuda reference requires that the reactive gas is not directly in contact with the surface of either electrode (Column 3, lines 29-31). This is the key of the Fukuda invention – to keep any reactants from coming in direct contact with any electrode. In order to keep the reactive gas stream away from the electrodes, the Fukuda reference teaches two different setups. In Figure 1, the reactive gas (11) flows through a separate central tube, while an inert gas passes around it. Only the inert gas contacts the electrodes, thus preventing any direct contact of the reactive gas with the electrodes.

In Figure 2 (referred to by the Examiner) the reactive gas stream is again separated by the walls of a tube from the inert gas and the electrodes. Both the inert gas and reactive gas enter a discharge space between electrodes 2 and 5. But note: Electrode 5 is prevented from direct contact with the reactive gas by the presence of the membrane to be coated. And as for electrode 2, while the diagram might cause one to conclude that the inert gas and reactive gases mix and therefore must both contact the electrode, the patent teaches exactly the opposite. In column 15, lines 29-45 describe the workings diagramed in Figure 2. "The voltage application electrode is provided so that the electrode is surrounded with the gas paths, whereby turbulent flow is difficult to occur in the discharging space, the inert gas contacts the voltage application electrode 2, and the reactive gas contacts the surface of substrate 1. The above structure of the electrode section is such that the voltage application electrode 2 does not directly contact the reactive gas for forming a layer..."

The Fukuda reference clearly teaches that the reactive gas and electrodes do NOT DIRECTLY contact, while Applicant's claim the reactants and carrier gas pass DIRECTLY between the electrodes. "Not directly" does not teach or suggest "directly" to one of ordinary skill in the art, and in fact teaches away.

Since the Fuduka reference fails to teach or suggest all of the limitations of Applicant's claims, and instead teaches exactly the opposite, there is no *prima facie* case of obviousness.

35 U.S.C. §103

Hammerschmidt in view Fukuda

Claims 1, 3, 5-6, and 11-14, stand rejected under 35 U.S.C. 103(a) as being unpatentable over Hammerschmidt (US 6,010798) in view of Fukuda (US 6,849,306). These references fail to create a *prima facie* case of obviousness over Applicant's claims as amended.

The Hammerschmidt reference describes a novel polymer electrolyte membrane arrangement. It offers little insight into the method for producing a proton-conducting

cation-exchange electrolyte membrane, which is the subject of Applicant's invention. The Hammerschmidt reference describes only generally the process for chemical deposition as a "plasma-chemical process", using as examples chemical deposition at "low-pressure plasma between 10^{-4} and 10 mbar", and as an alternative "sputtering methods". (Col 3, lines 40 – 55). Both of these methods are very different from the atmospheric pressure plasma deposition method claimed by Applicant, and the differences have been clearly discussed in the many responses to rejections filed by Applicant in this application.

Therefore the Hammerschmidt reference merely teaches that a catalylitic membrance may be made, teaching and exemplifying only methods that teach away from Applicant's invention. One of ordinary skill in the art would not be motivated by a teaching of a membrane, and disclosure only of methods for forming that membrane that do not contain all of Applicants claimed elements and limitations, to practice Applicant's claims. While Applicant agrees with the Examiner that the Hammerschmidt reference does not necessarily mean to limit techniques only to those disclosed, non-disclosure of Applicant's technique in Hammerschmidt dies not suggest Applicant's claims, and disclosure only of other methods is a teaching away.

The Fukuda reference is discussed above.

The Examiner argues that Applicant cannot show non-obviousness by attacking the references individually. Applicant has shown that neither reference alone has all of Applicant's claim limitations, and some limitations of Applicant's claims are not found in either reference, it therefore is shown that the references combined do not teach or suggest all of Applicant's Claim limitations, and therefore fail to provide a *prima facie* case of obviousness. Neither the Hammerschmidt or Fukuda references, alone or together teach or suggest applicant's claims (as amended) of an atmospheric pressure plasma deposition method for forming a proton-conducting cation-exchange electrolyte membrane in which the carrier gas passes directly between the electrodes.

Hammerschmidt in view Fukuda and Schutze

Claim 4 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Hammerschmidt (US 6,010798) in view of Fukuda (US 6,849,306), further in view of Schutze. The Schutze The Schutze reference teaches a plasma jet using flowing helium. Applicant's amended claims cite a method without adding noble gases to the DECVD carrier gas. The Schutze reference not only fails to teach or suggest Applicant's claim limitation of no added noble gas, but teaches away from Applicant's claims by requiring a noble gas. The Schutze reference fails to correct the deficiencies of the other cited references, fails to teach or suggest Applicant's claim limitations, and teaches away from Applicant's claims.

Further in view of Yasumoto

Claim 7 stands rejected further in view of Yasumoto (US 2003/0096154). The Yasumoto is a secondary reference cited by the Examiner to teach the spraying of the catalyst onto the surface of the polymer electrode membrane. Applicant's do not claim a method in which a catalyst is sprayed onto a polymer electrode membrane, but rather a discharge enhanced chemical vapor deposition method. Thus the Yasumoto reference fails to teach Applicant's claims.

Further in view of Nanaumi

Claims 8-9 stand rejected under 35 U.S.C. 103(a) as being unpatebtable further in view of Nanaumi (US 2004/0180250).

The Nanaumi reference is cited to cite polymer electrolyte membrane structures. However the Nanaumi reference fails to teach or suggest Applicant's many claim limitations, and fails to correct the many deficiencies of the other references cited.

Further in view of Kamo

Claims 14 and 15 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Dearnaley (US Patent Number 6,159,533) in view of Schutze in view of Fornsel

(WO 01/32949, US 6,800,336), and further in view of Kamo (US 2003/0059659). The Kamo reference is a secondary reference cited to show the use of a platinum alloy in the anode side of an electrolyte membrane. While the Kamo reference discloses a platinum/ruthenium alloy for a fuel cell electrode, the platinum/ruthenium alloy is supported on a carbon powder, rather than directly on a membrane as claimed by Applicant. In Example 2, the platinum/ruthenium alloy is screen printed using a slurry. One in the art would not be motivated by this method alone – or in combination with the other cited reference to practice all of the limitations in Applicant's amended claims.

Further in view of Haug

Claim 16 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Dearnaley (US Patent Number 6,159,533) in view of Schutze in view of Fornsel (WO 01/32949, US 6,800,336), and further in view of Haug. The Haug reference is a secondary reference cited to show the deposition of multiple catalyst layers. The Haug reference demonstrates the use of a vacuum sputter deposition system for producing a PEM. The disclosure of a multiple layer of catalyst by methods teaching away from Applicant's claimed method fails to heal the defects of the cited art to present a *prima facie* case of obviousness.

Conclusion

The references cited, either alone or in combination, fail to teach or suggest all of Applicant's claim limitations, and therefore fail to present a *prima facie* case of obviousness over Applicant's amended claims. For the above reasons the present claims 1, 3-9, and 11-16 are believed by the Applicant to be novel and unobvious over the prior art, thus the claims herein should be allowable to the Applicant. Accordingly, reconsideration and allowance are requested.

Respectfully submitted,

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